

**PRELIMINARY OBSERVATIONS OF A GROUP OF PIG-TAILED MACAQUES
(*MACACA NEMESTRINA*) IN KHAO CHI-ON NON-HUNTING AREA, CHONBURI
PROVINCE, SOUTHEAST THAILAND**

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A B S T R A C T

A group of 40 pig-tailed macaques was observed for 3 months (February-April 1988) in Khao Chi-on Non-hunting area, Chonburi Province. Details of social behaviour, group composition and range were recorded and compared with previous studies of pig-tailed macaques.

I N T R O D U C T I O N

Khao Chi-On, a designated non-hunting area situated 15 km north-east of Sattahip, Chonburi Province ($12^{\circ} 46' N$, $100^{\circ} 59' E$), was established in 1985. It covers an area of only 368 ha but is completely isolated not only from similar protected areas but also from the remaining forested land in the vicinity. Although small in size, it supports a range of mammal species of which the pig-tailed macaque *Macaca nemestrina* is the sole primate representative (Appendix 1).

S T U D Y A R E A

Khao Chi-On is one of a series of small uplifted and heavily faulted limestone hills which rise above the coastal plain in the extreme south of Chonburi Province. It consists of 3 peaks, the highest of which reaches 318 m (Figure 1). Due to extensive faulting, areas of exposed rock are common, and slopes are steep; the most extreme example of this is found in the cliff face of the main peak (Figure 2). Soils tend to be thin and basic, which restricts the quality of vegetation by restricting it to trees with shallow root systems.

The area receives about 1300 mm of rainfall per annum, 65% of which falls in the wet season from May to October (LEKAGUL & MCNEELY, 1977). Surface water is scarce, due also to the limestone geology, with only one stream flowing in the rainy season. For the remainder of the year, the only surface water is in two man-made reservoirs.

The original vegetation of the region is classified as mixed deciduous forest (LEKAGUL & MCNEELY, 1977), but this has been modified at Khao Chi-On by

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deforestation. Before protection was established, 18 families were practising shifting cultivation here resulting in the loss of large tracts of forest. At the present time forest accounts for only 117 ha, which is 35% of the total area. Three main vegetation zones can be recognised (Figure 3A):

1. Natural or secondary forest.
2. Grasslands or other deforested land.
3. Old banana and new acacia plantations.

In those areas untouched by deforestation, dry deciduous forest exists with species including *Sterculia foetida*, *Afzelia xylocarpa*, *Lagerstroemia balansae* and *Pterocarpus macrocarpus*. This gives a well-developed canopy up to 20 m, with vines and ground plants forming a lower layer. Interspersed in this are dipterocarp species including *Anisoptera costata* and *Dipterocarpus alatus*, which reach 30 m, but these are less common. Where the slopes are very steep and the soils thin, and also where secondary forest is emerging, the dominant plant is *Pandanus odoratissimus*, which grows only to a height of 5 m. *Pandanus* also forms a low canopy level where it grows in the forest. Interspersed are bamboo thickets and banana plants, *Musa acuminata*, which form the boundary between forest and grassland. Some parts of the grasslands have been replanted with trees by the Forest Department, but the trees are still small and not fully established.

The protected area is entirely surrounded by cultivated land, planted principally in cassava, so that all the fauna contained therein is effectively isolated. Due to its small size the reserve is effectively protected by the Forest Department, and incursions are now rare.

FOODEN (1975) recognises two sub-species of pig-tail macaque in Thailand, *Macaca n. nemestrina* and *Macaca n. leonina*, which can be differentiated by the colouration and the position of the tail. The animals that occur at Khao Chi-On have a noticeably blackened back, and the tail is arched rearward rather than over the back, except during acts of aggression or fright when it is arched over the back. It has thus been designated as *Macaca n. nemestrina*.

METHODS

The study was undertaken over a 3-month period (February-April, 1988). The macaques were never fully habituated, only being tolerant of the observer at 50 m. This, coupled with the density of vegetation and difficult terrain, made continuous observation difficult. Old logging trails were already in existence in the area; these were used as access routes and for location of the macaques, using visual or auditory signs (branch shaking or calling). The macaques were also observed using 10x binoculars. Data were collected on the daily movements of the animals to assess what proportion of available land was being utilised. Plants were identified with the aid of persons familiar with the local flora and SMITINAND (1980).

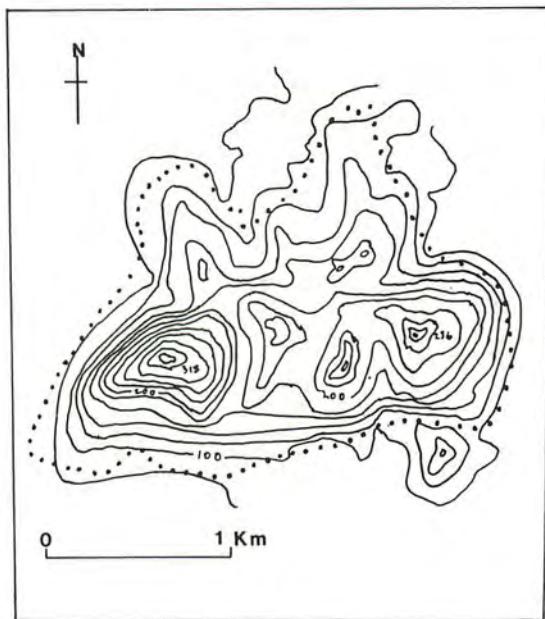


Figure 1. Relief map of Khao Chi-On, showing the boundary of the non-hunting area (.....). Redrawn from 1:50,000 Sheet 5134 I, Royal Thai Survey Dept.



Figure 2. Khao Chi-On peak, showing forest vegetation (April).

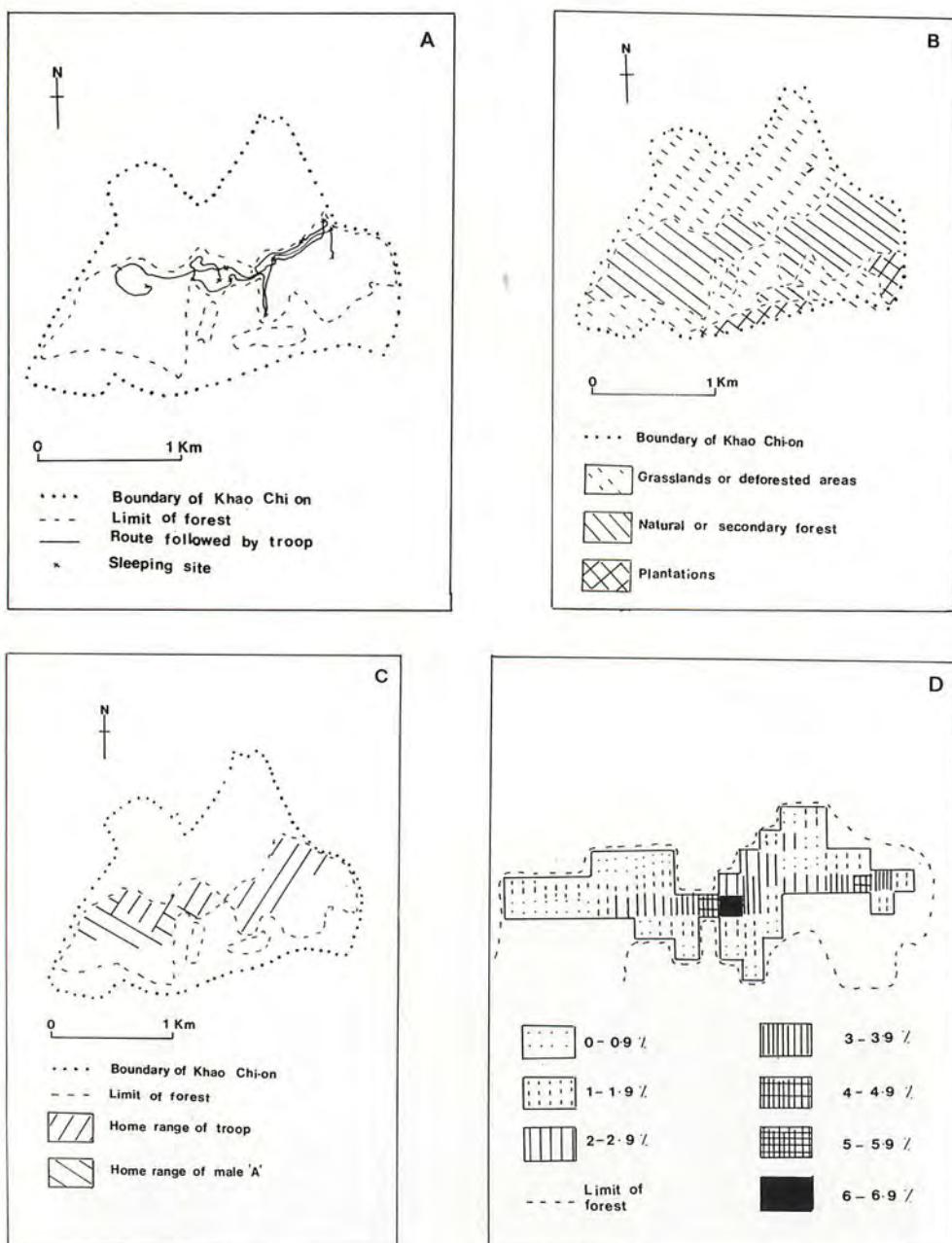


Figure 3 A: Land-use map of Khao Chi-On.

B: Home range use by *Macaca nemestrina* over a 14-day period.C: Home range of *Macaca nemestrina*.

D: Home range use, expressed in percentage of observations in 1-hectare quadrats.

O B S E R V A T I O N S

Group Composition

It was possible to take an accurate census of the one troop inhabiting Khao Chi-On by counting them as they crossed the road that effectively divides their home range in half. By using the definitions in Table 1, the group comprised 3 adult males, 9 adult females, 2 subadult males, 15 large juveniles, 9 small juveniles and 2 infants; this gives a total troop population of 40.

Table 1. Definitions of age classes (after CALDECOTT, 1986).

Age	Features
Infant	Very small, dark brown, still mother-carried.
Small juvenile	Small, independently mobile but mother-carried when danger occurs.
Large juvenile	Larger and always independently mobile.
Subadult male	Physique like that of adult but not as heavy.
Adult male	Very large size with dark brown/black dorsal stripe, especially prominent in dominant male.
Adult female	Size similar to large juvenile, with prominent nipples and large ischial pads; the pads are swollen when the female is in oestrus.

This group compares closely in size with that studied by CALDECOTT (1986) at Limas Belas, Malaysia, which had 45 individuals although in a smaller study area of 70 ha. The group at Pasoh, Malaysia, a larger site of 1600 ha, had 30 individuals. A range of 12–79 animals per group, with a median of 20, has been observed for *Macaca nemestrina* at other sites in Thailand (FOODEN, 1975; EUDEY, 1980). These group compositions are compared in Table 2.

Table 2. Composition of groups of pig-tailed macaques.

Study site	Reference	Ratio, adult male: adult females	Ratio, adults: juveniles
Khao Chi-On	This study	1:3	1:2
Limas Belas	CALDECOTT, 1986	1:8	1:1.7
Pasoh	CALDECOTT, 1986	1:5	1:1.2

In addition to the main troop there were 2 free-ranging solitary males. Eviction from the troop is common and has been described for a number of macaque species (MELNICK & PEARL, 1986; SUGIYAMA, 1976). The ousted males subsequently either form new troops with females taken from the old troop, join other troops, or remain solitary. In the case of Khao Chi-On, the second option was unavailable, as there were no other troops in the area.

The group structure did not change for the duration of the study and no births were seen. Only one of 9 females did not have an infant or small juvenile and it was surmised from her appearance and size that she had only recently become mature.

Intra-group Behaviour

The troop moved consistently throughout the day, travelling and feeding intermittently. If a particularly large tree was encountered in fruit, the troop would remain in that place for up to 2 hours, with the juveniles staying even longer. Usually the troop travelled in a dispersed fashion over a large area, with up to 100 m separating the extremities of the group. Due to this wide dispersion, the troop frequently split up into smaller subunits, with juveniles tending to congregate together. This pattern of dispersion has been noted for other macaque species (SOUTHWICK et al., 1985; LINDBURG, 1977) and appears to be an adaptation to maximise food intake. However when a good food source is encountered, the whole troop will regroup at it.

The troop stopped travelling about an hour before sunset when it would enter the trees chosen as sleeping sites. Usually the troop occupied sleeping sites close together and did not sleep in distinct subgroups as has been found in other species (ALDRICH-BLAKE, 1980). Certain sleeping sites in some of the larger trees were reused on a regular basis, but never on consecutive nights. The day range travelled over a 14 day period ranged from 250 m to 800 m and gave a mean of 462 m, compared with 100 m found at Limas Belas by CALDECOTT, 1986). The short range figure of 250 m occurred on a day when a thunderstorm inhibited movement (Figure 3B).

About 20% of the area of Khao Chi-On is covered by *Pandanus* solely, but elsewhere there is a better developed canopy, although it never reaches the dimensions found in Malayan rain forest. Pig-tailed macaques are more terrestrial than other macaques but CALDECOTT (1986) mentions that terrestrial travel also appears to be associated with low food availability. At Khao Chi-On the macaques spent most of their time below 10 m in the lower canopy (55% of spot observations), but even while travelling through the area dominated by *Pandanus* they rarely descended to the ground. Terrestrial travel occupied only 10% of time and was used more by the adult males. Females were only seen on the ground when they had no alternative either in crossing a path or reaching an isolated fruiting tree. The higher canopy was utilised when feeding on large fruit trees and in the evenings when the juveniles played.

Antagonism was heard on a number of occasions with screams from

juveniles, but no serious fighting amongst the adult males was seen, though fighting could be deduced from the scars on the dominant male. As one of the solitary males ('Reg') followed the troop around, aggressive acts were seen between him and the dominant male but he always retreated before physical contact. On one occasion Reg was forced to retreat by another male in the troop. The dominant male was nearby but took no part in the proceedings. Reg also used agonistic acts such as branch shaking more than the adult males in the troop. This was especially common in the hour before sunset when he often occupied the tallest tree in the vicinity, usually leafless and conspicuous. Although this behaviour was done as little as 100 m from the troop's sleeping site, it never evoked a response. During the study Reg became progressively more detached from the troop, with a resultant drop in aggressive acts initiated towards him, though he still continued to follow the troop at a distance.

Home Range

Home range area was determined by monitoring and mapping the troop's position over the period researched and drawing a line around the outermost points (Figure 3C). The area was 58 ha assuming that the macaques did not venture outside the forest (something that was never observed), which represents under 50% of the available forested area. Solitary male 'A' had a distinct but overlapping home range (23 ha). This leaves 46 ha of unexploited forest habitat. This appears surprising in view of the fact that the total forest area is small, but could indicate high food availability and possibilities for the troop to expand or divide into other troops. The population density is also higher than that at three other study sites (Table 3).

Home range use was fairly uniform (Figure 3D). Because the two halves of the range were joined by a small piece of forest, this area was heavily used, but there did not appear to be a distinctive heavily used core area as found in other macaque species (ALDRICH-BLAKE, 1980; CALDECOTT, 1986).

Male 'A' maintained his own home range and only came into contact with the troop when they entered his range (Figure 3C). Then he only associated with the other solitary male, Reg, and not with the rest of the troop. As Reg followed the troop around, he did not have a separate home range.

Diet

The pig-tailed macaque is the most frugivorous of all the macaque species (CALDECOTT, 1986) and Khao Chi-On supports a wide range of fruit trees which the macaques were observed eating (Appendix II). *Pandanus*, the dominant species, was only utilised by the macaques for its buds, but due to its prevalence this skews the number of observations of items on which the macaques were seen feeding. Of the 112 feeding observations, 30% were on buds, 56% fruit, 8% leaves, 4% bark and 2% invertebrates. At Limas Belas, 74% of feeding observations were of fruit and

only 3% on buds (CALDECOTT, 1986). Feeding was observed in all available strata and throughout the day. It is interesting to note that the macaques never utilised the old banana plantation outside the forest, presumably because they would have had to cross an area of grassland to gain access and cover was limited. Wild bananas (*Musa acuminata*) were eaten in the forest.

There is a relationship between range size and food availability; the more dispersed the food sources, the larger is the range size (CALDECOTT, 1986). The small home range size and the prevalence of arboreal travel at Khao Chi-On would appear to indicate a high food availability. This is supported by the relatively high population density and lack of utilisation of the whole forested area. The findings from Khao Chi-On are broadly similar to those at Limas Belas with an isolated group and small home range and day range. At Pasoh, a larger area of undisturbed rain forest, the macaques' territory was much larger, with a corresponding increase in the number of dipterocarp trees. These trees are not utilised by macaques as food; dipterocarp trees are relatively scarce at Khao Chi-On.

C O N C L U S I O N S

The preliminary observations at Khao Chi-On found that the area supported one troop of 40 animals and 2 solitary males. The large number of young animals in the group would seem to indicate a steady rate of population increase. The vegetation in Khao Chi-On and high food availability seem capable of supporting a high population of pig-tailed macaques; the non-hunting area is also sufficiently well patrolled to guarantee the protection of the animals within. There is only 50% usage of the forested land by the macaques at present, giving room for the group to expand or subdivide. However several points emerge when evaluating the long term prospects of the macaque population at Khao Chi-On.

Firstly there is a finite limit to the expansion of the population because the protected area is surrounded by agricultural land. At present there is one solitary male occupying his own home range and one male in the process of being ejected from the troop, who will need to establish his own respective range. There is the probability that more males will be evicted from the troop in the future, which will generate more pressure for space. Secondly, Khao Chi-On has only been established as a non-hunting area for 2 years. Prior to this macaques and other fauna were hunted by the local people and the population increase of the troop would have been more tightly controlled. With hunting now nonexistent this constraint on the population has been removed, and the macaques have few, if any natural predators.

Thirdly, because Khao Chi-On is isolated there is no possibility of other pig-tailed macaques joining the troop; this may have consequences for the group's genetic variability in the long term.

Lastly, only 35% of Khao Chi-On remains as forest. The macaques do not inhabit any vegetation zone other than forest, so 65% of the protected area is unavailable

to them. The Forest Department has planted some of the grassland, but this is a long term project; funds are also unavailable for replanting the entire deforested area.

Khao Chi-On is a good example of an area that has been well protected, but where this protection will bring its own specific problems in the future. It remains to be seen what will happen when the carrying capacity of the forested area is reached and the macaques can no longer expand into other areas. Further studies will be of interest to observe what effects this pressure of space have on the population of macaques of Khao Chi-On.

Table 3. Ranging area and population density in studies done on pig-tailed macaques.

Study area	Forest type	Home range (ha)	Core area (ha)	Population density (km ²)	Reference
Khao Chi-On	Dry deciduous	58	None apparent	68	This study
Limas Belas	Tropical rain	60–70	28	126	Caldecott
Pasoh	Tropical rain	830	360	3.6	Caldecott
Sumatra	Mangrove	320	?	17.9	Crockett & Wilson

A C K N O W L E D G E M E N T S

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Appendix 1. Mammal species seen or reported in Khaoy Chi-On.

Species name	Common name	Type of identification
<i>Macaca nemestrina</i>	Pig-tailed macaque	Sighted
<i>Viverra zibetha</i>	Large Indian civet	Reported by workers
<i>Viverra indica</i>	Small Indian civet	Reported by workers
<i>Felis bengalensis</i>	Leopard cat	Sighted
<i>Felis viverrina</i>	Fishing cat	Sighted
<i>Menetes berdmorei</i>	Indochinese ground squirrel	Sighted
<i>Callosciurus flavimanus</i>	Belly-banded squirrel	Sighted
<i>Lepus peguensis</i>	Siamese hare	Reported by workers
<i>Manis javanica</i>	Malaysian pangolin	Reported by workers
<i>Hystrix brachyura</i>	Malayan porcupine	Faeces seen

Appendix 2. Tree species found at Khao Chi-On, including those utilized by pig-tailed macaques.

Species	Family	Parts eaten by macaques
<i>Afzelia xylocarpa</i> (Kurz) Craib	Leguminosae, Caesalpiniodeae	leaves, shoots, bark
<i>Anisoptera</i> sp.	Dipterocarpaceae	
<i>Artocarpus heterophyllus</i> Lamk.	Moraceae	leaves
<i>Carica papaya</i> L.	Caricaceae	fruit, leaves
<i>Dipterocarpus alatus</i> Roxb. ex G. Don	Dipterocarpaceae	
<i>Eugenia cumini</i> (L.) Druce	Myrtaceae	
<i>Ficus annulata</i> Bl.	Moraceae	fruit, shoots
<i>Irvingia malayana</i> Oliv. ex A. Benn.	Irvingiaceae	
<i>Lagerstroemia balansae</i> Koehne	Lythraceae	
<i>Leucaena leucocephala</i> (Lamk.) de Wit	Leguminosae, Mimosoideae	leaves
<i>Litchi chinensis</i> Sonn.	Sapindaceae	fruit
<i>Mangifera caloneura</i> Kurz	Anacardiaceae	fruit
<i>Morinda coreia</i> Ham.	Rubiaceae	
<i>Musa acuminata</i> Colla	Musaceae	fruit
<i>Nephelium hypoleucum</i> Kurz	Sapindaceae	
<i>Pandanus odoratissimus</i> L.	Pandanaceae	shoots
<i>Phyllanthus emblica</i> L.	Euphorbiaceae	
<i>Pterocymbium javanicum</i> R. Br.	Sterculiaceae	
<i>Sandoricum koetjape</i> (Burm.f.) Merr.	Meliaceae	
<i>Schoepfia acuminata</i> Wall.	Olacaceae	
<i>Sterculia foetida</i> L.	Sterculiaceae	
<i>Streblus asper</i> Lour.	Moraceae	leaves, bark, shoots
<i>Vitex glabrata</i> R. Br.	Verbenaceae	leaves, shoots

